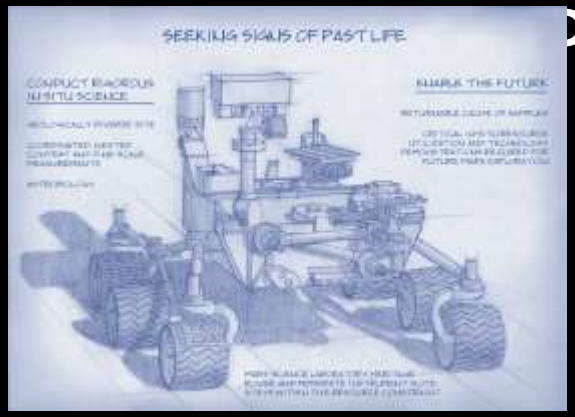
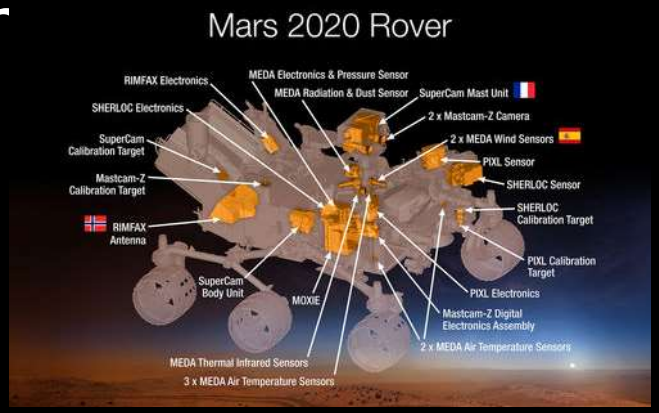
From Noachian to Amazonian, Clays, Sediments and Igneous Rocks in Oxia Planur





P. Thollot[1], C. Quantin[1], J. Carter[2], et al.

including work by: L. Lozach[1], J. Davis[3], P. Grindrod[3], J. Fernando[1], D. Loizeau[1] M. Pajola[4], J. Broyer[1], E. Baratti[5], R. Sandro[4], P. Allemand[1], B. Bultel[1], C. Leyrat[6], A. Ody[1]

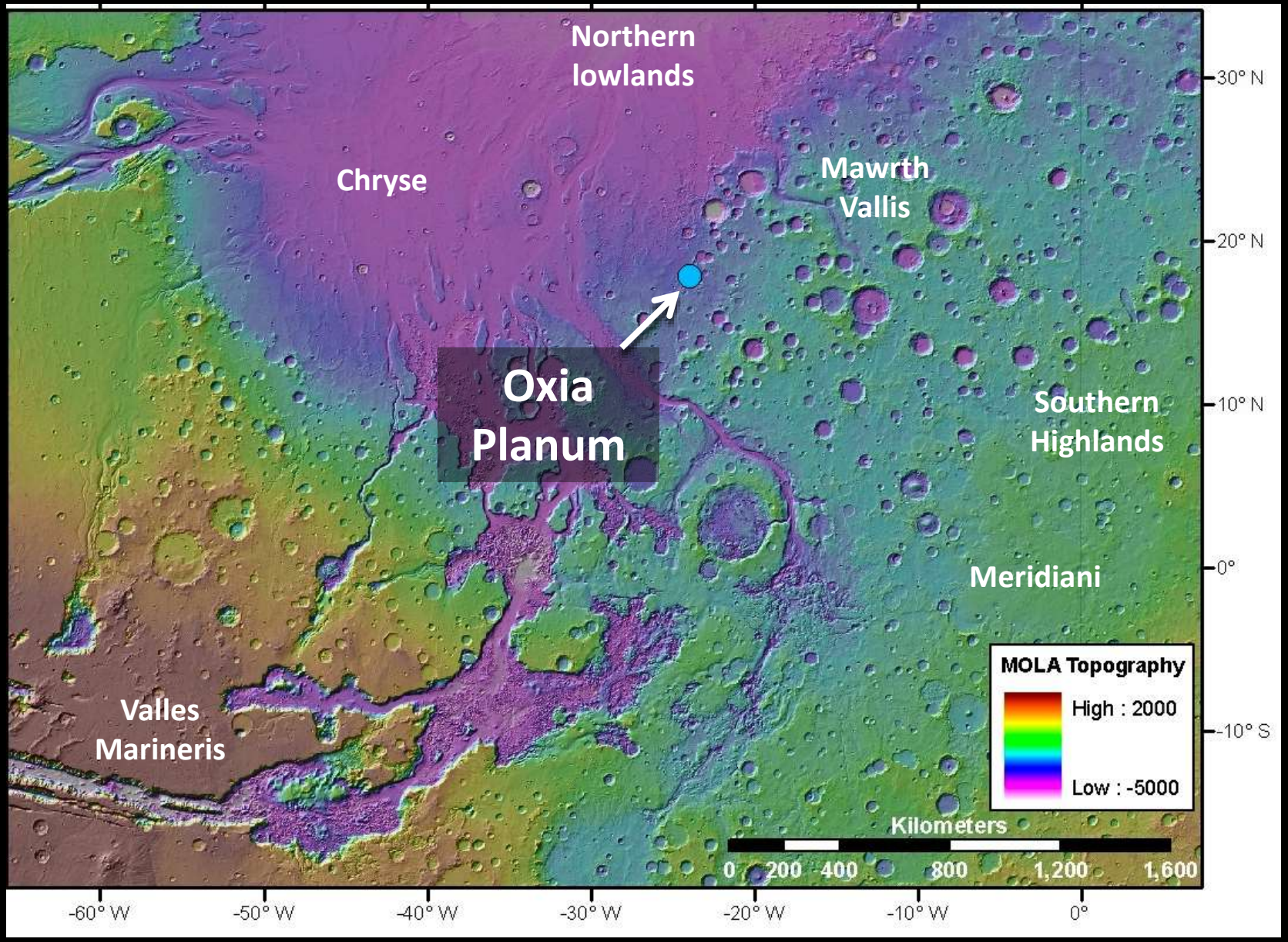
(1) Laboratoire de Géologie de Lyon, France. (2) IAS, France. (3) University college london (UK). (4) University of Padova, Italia. (5) University of Bologna, Italia. (6) OPM

Mars 2020 Second Landing Site Workshop
August 4–6, 2015, Monrovia, CA

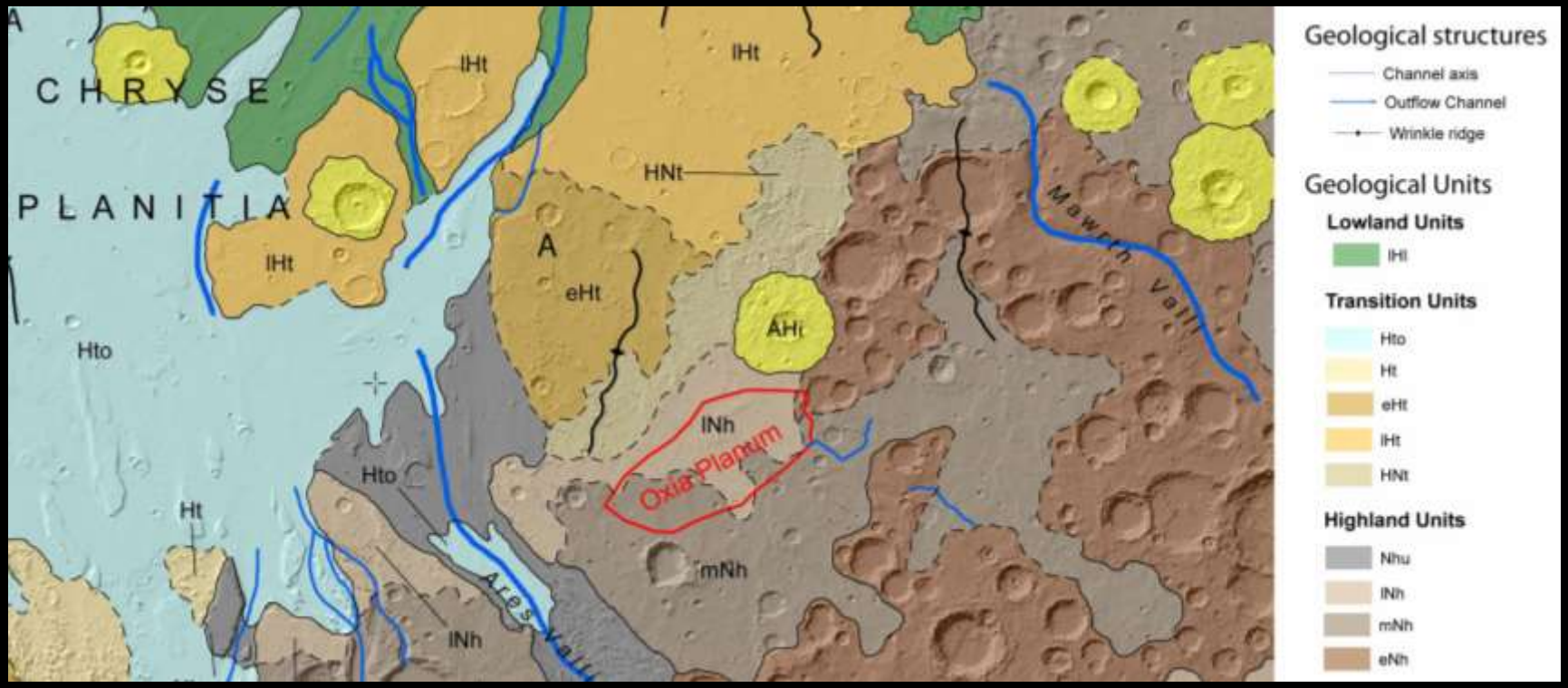
Oxia Planum Highlights

1. **Noachian** basement (4 Ga), layered (sedimentary or igneous) and altered
2. **Fluvial** valleys and channels on Noachian basement
3. **Delta-fan** likely lN/eH (3.8-3.6 Ga), synchronous with fluvial features
4. **Fe/Mg-phyllosilicates** (ferrous iron: Fe2+) in late noachian unit.
5. Other alteration minerals include **Al-phyllosilicates** in delta-fan, **hydrated silica** on edge of igneous unit, possible **carbonates** with Fe/Mg-clays.
6. **Early Amazonian lava flow unit** (~ 2.6 Ga): igneous unit with crater count and precise age.
7. **Continuing erosion** during Amazonian: **renewing of surface outcrops** and **renewing of potential biosignatures**.
8. Impact craters forming natural cross-sections, also secondaries from large nearby craters.

Oxia Planum: location



1. Noachian basement



lNh

Late Noachian highland unit— Mostly plains forming, rugged in places. May be hundreds of meters thick. (lat –20.74° N., long 354.35°

Occurs commonly in highland depressions, as well as sparsely in higher-elevation parts of the lowlands. Superposes units mNh, mNhm, eNh, and eNhm;

Undifferentiated impact, volcanic, fluvial, and basin material. Lightly to heavily degraded and (or) deformed

mNh

Middle Noachian highland unit— Uneven to rolling topography; high-relief outcrops that extend hundreds to thousands of kilometers. Commonly layered in crater walls. May be hundreds of meters to more than a kilometer thick.

Extensive in the equatorial to southern highlands. Superposes units eNh and eNhm; gradational with units mNhm, Nhu, Nhe, Nve, and HNt and ANa (Noachian parts); overlain by units lNh, lNv, HNt (Hesperian part), HNhu, HNb, eHb, eHv, eHh, eHt, Hp, Ht, Hto, Htu,

Undifferentiated impact, volcanic, fluvial, and basin materials. Moderately to heavily degraded

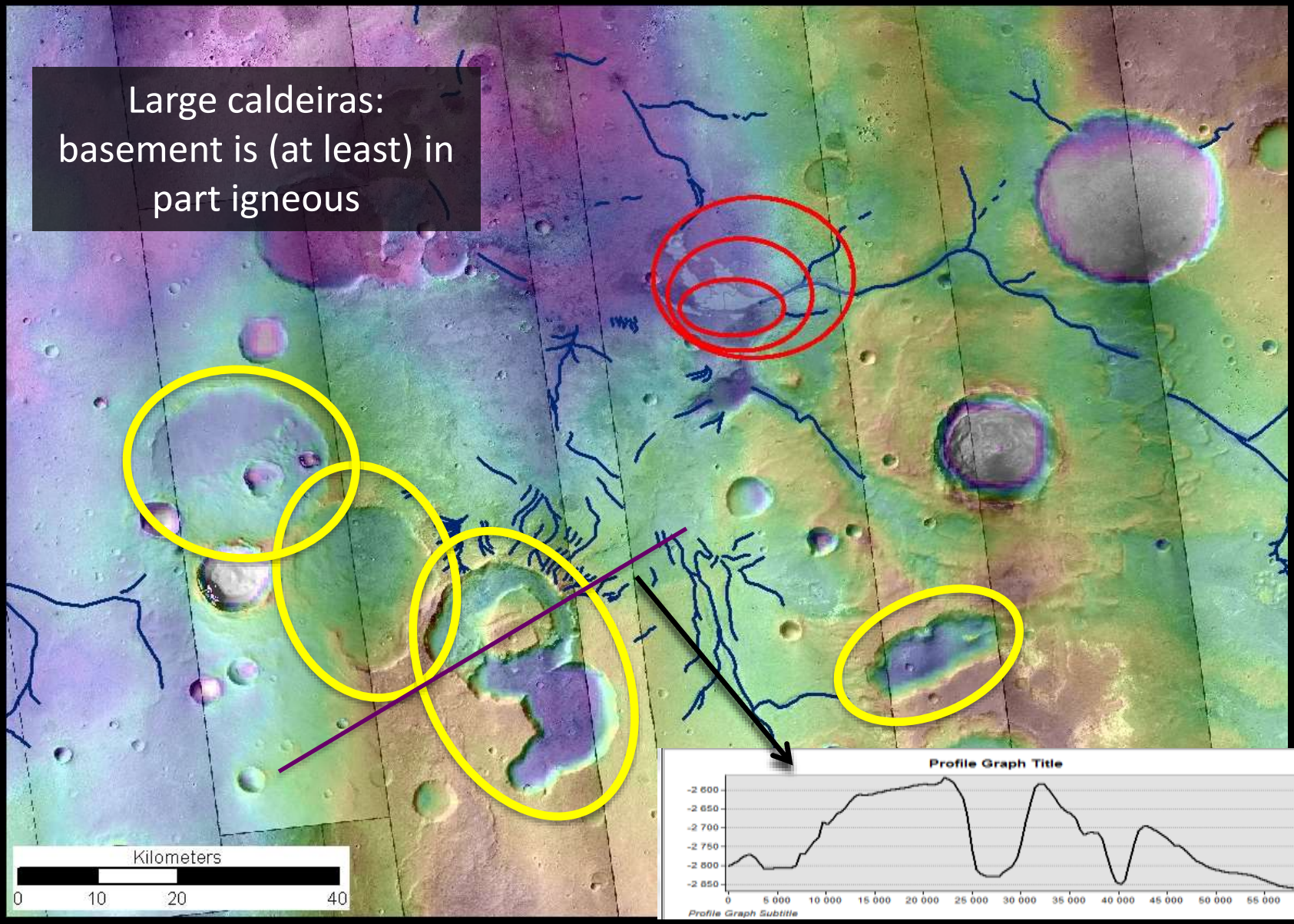
1. Noachian basement: age

Crater counts on Oxia-Mawrth region

(figure removed)

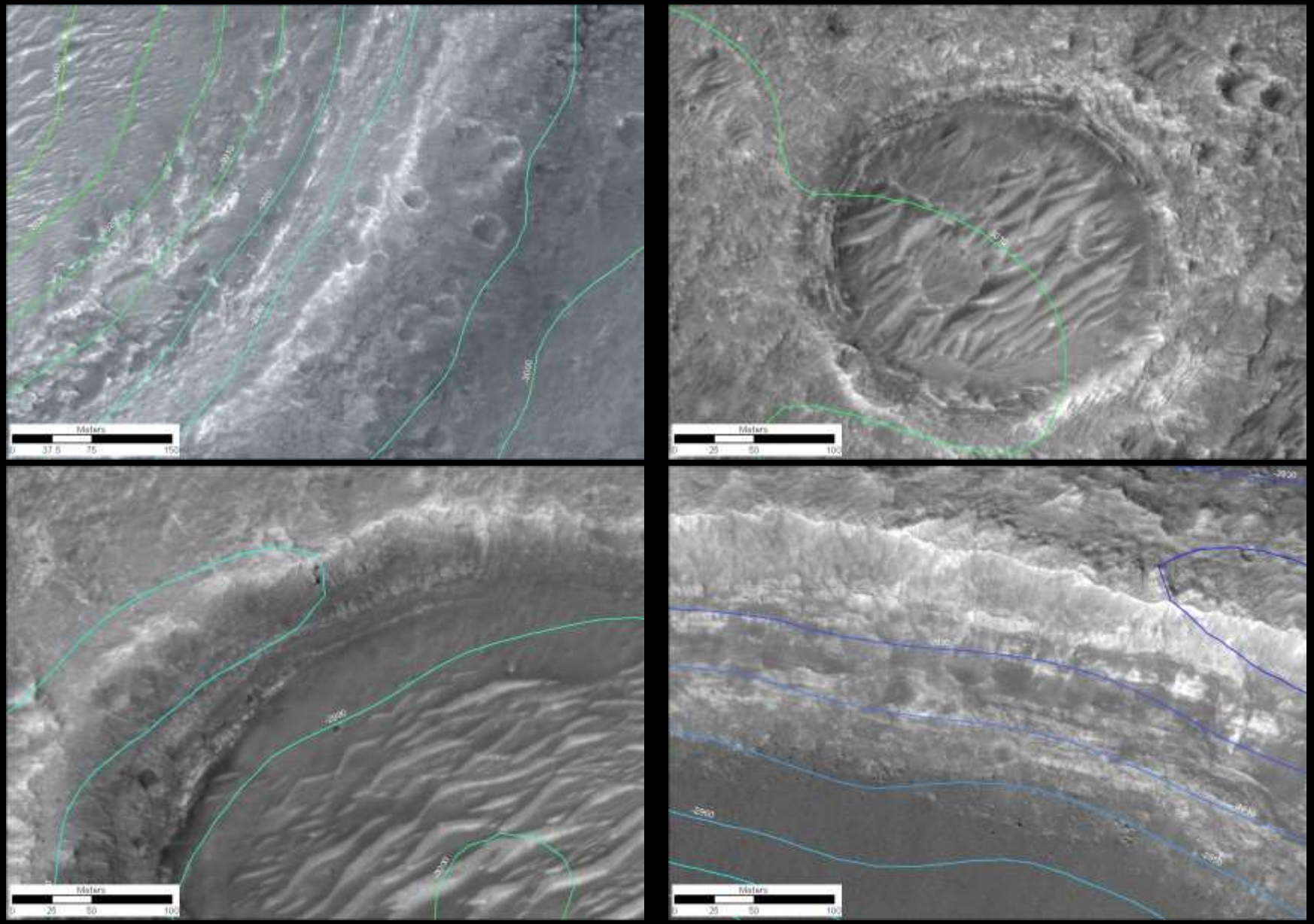
- Oxia-Mawrth Region basement is **ancient**: **4 Ga (+/- 200 Ma)**
- Intense crater obliteration from 4 Ga to 3.6 Ga: geologically active
- Moderate but continuous erosion since 3.6 Ga

1. Noachian basement: ancient volcanism

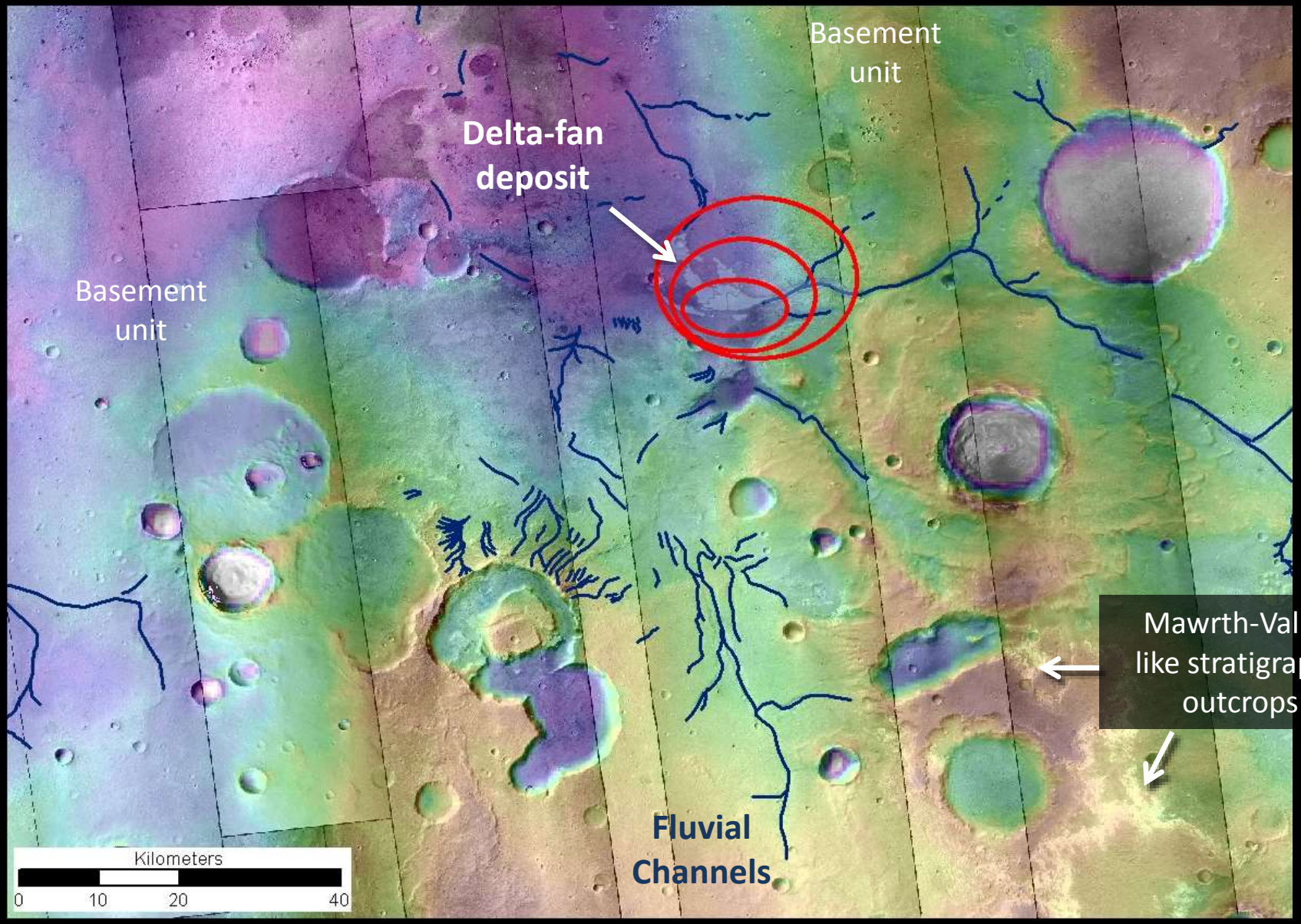


1. Noachian basement: layered

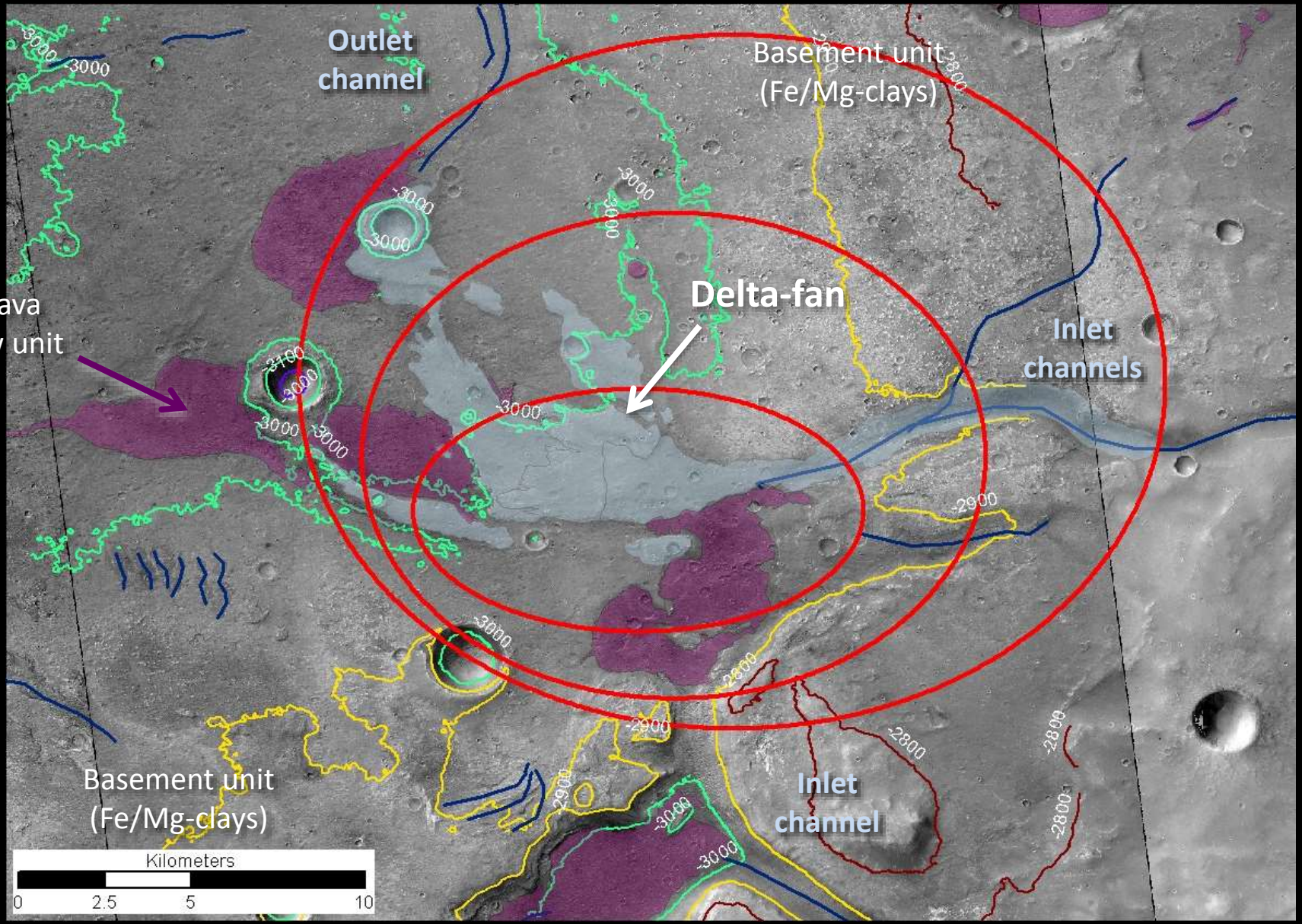
(8.) Impact craters walls inside ellipse expose basement outcrops



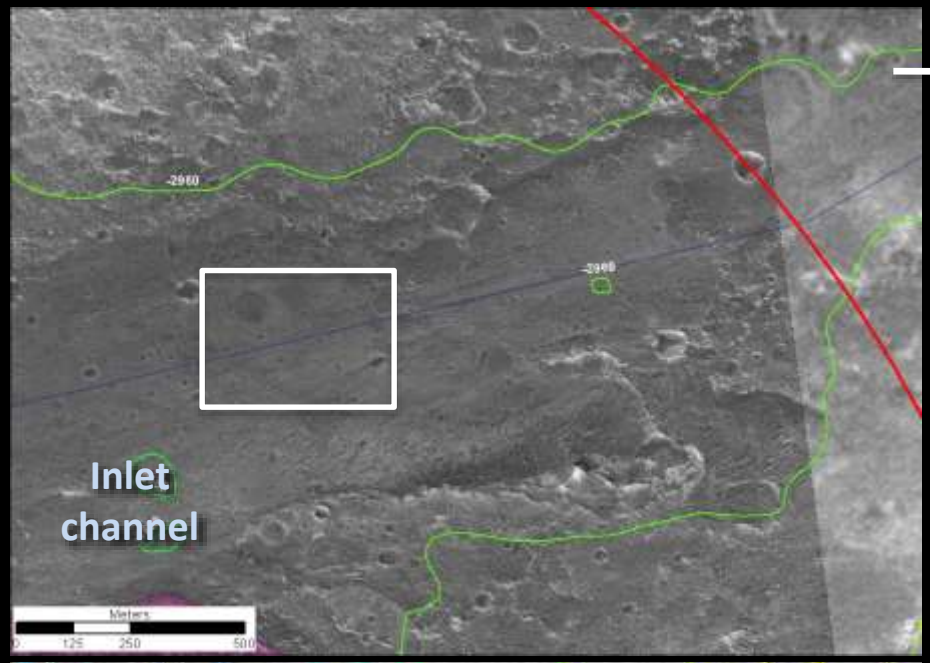
2. Regional fluvial morphology (IN): valleys & channels

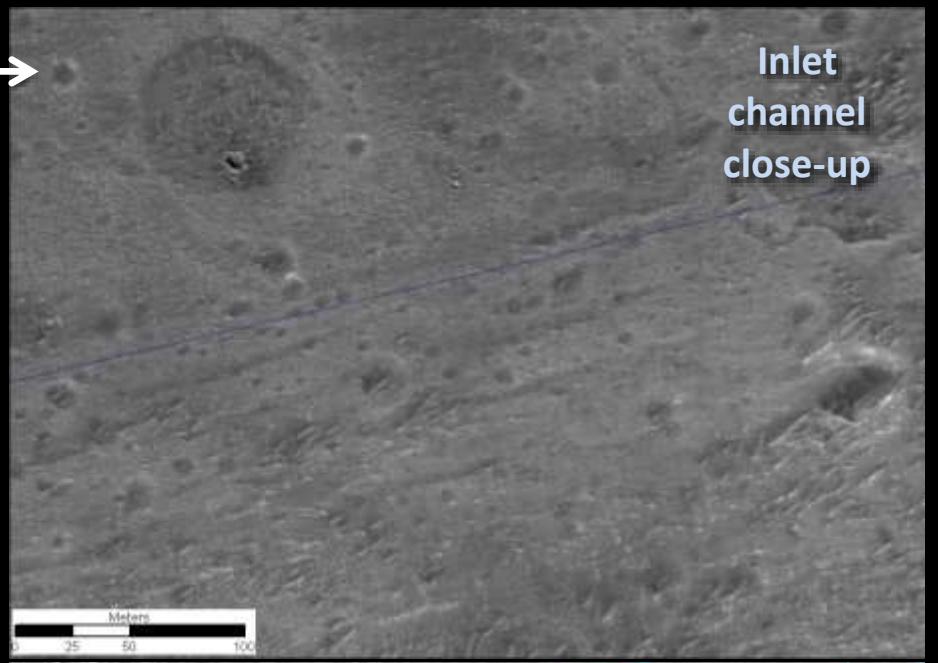


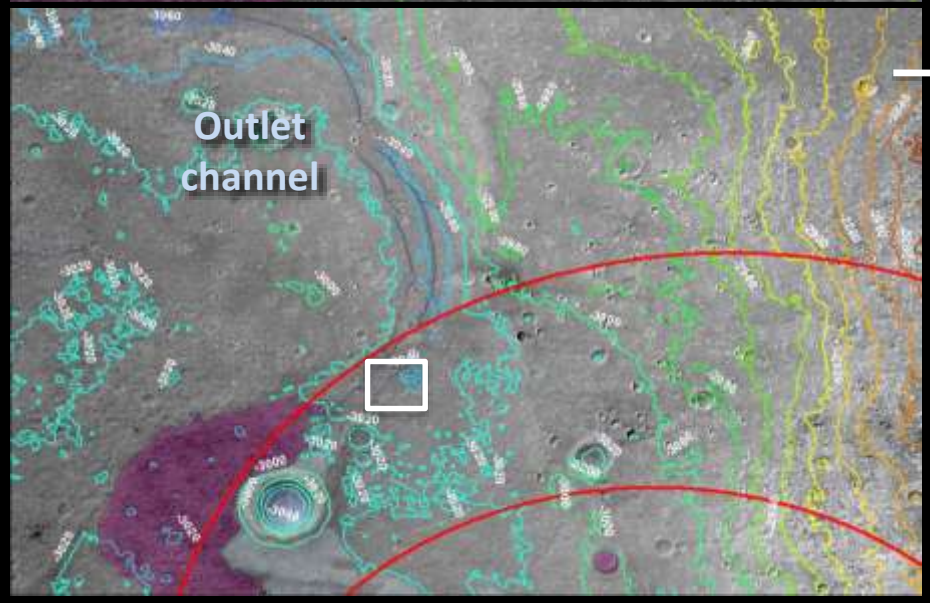
2./3. Delta-fan in paleo-basin as main target
(with inlets and outlet)

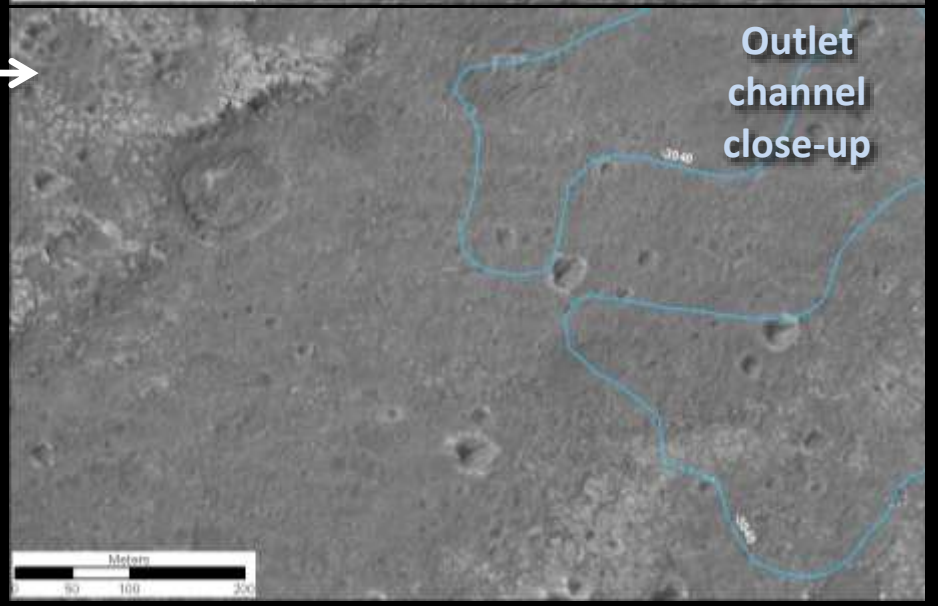


2. Fluvial morphology details: valleys & channels



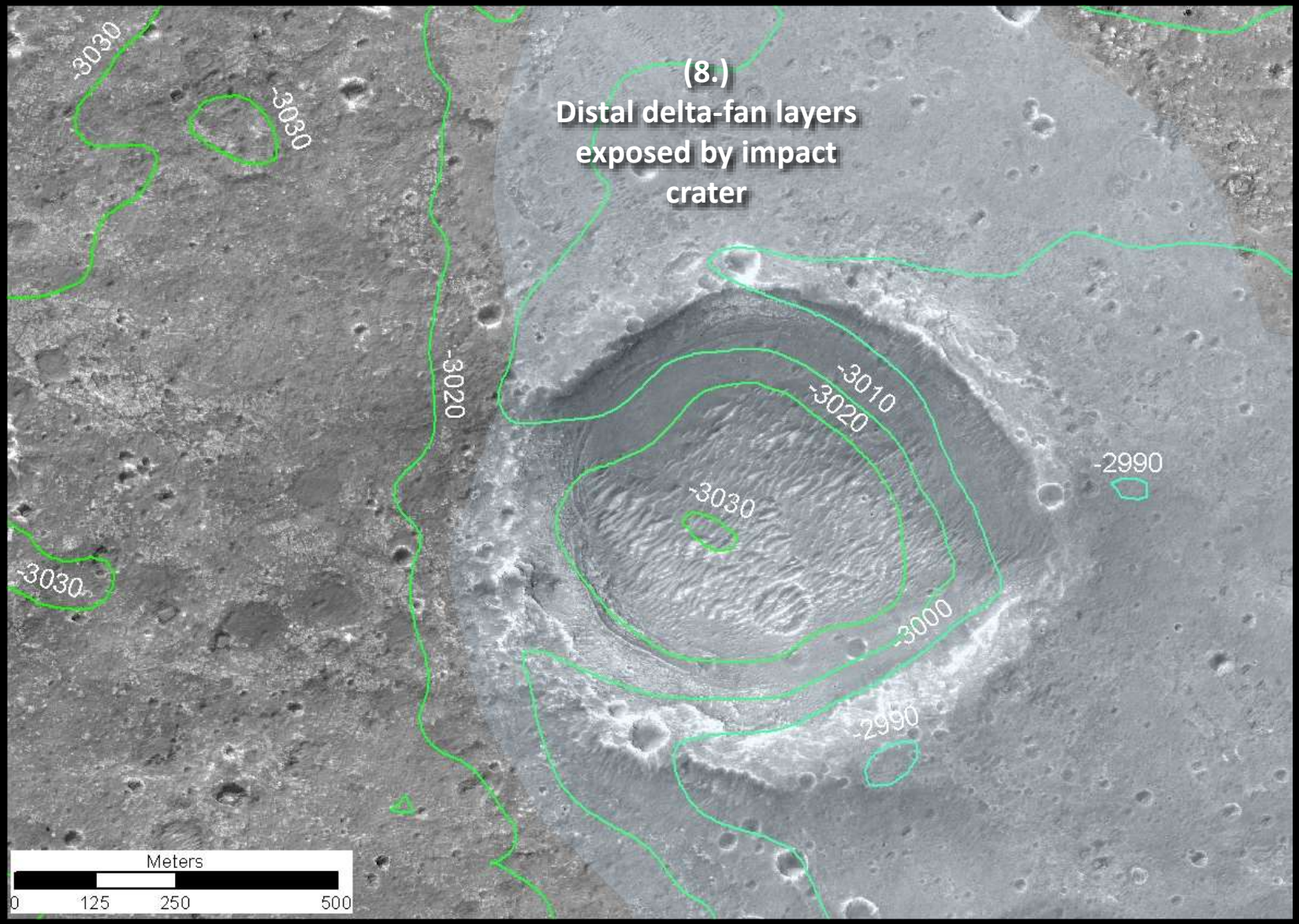






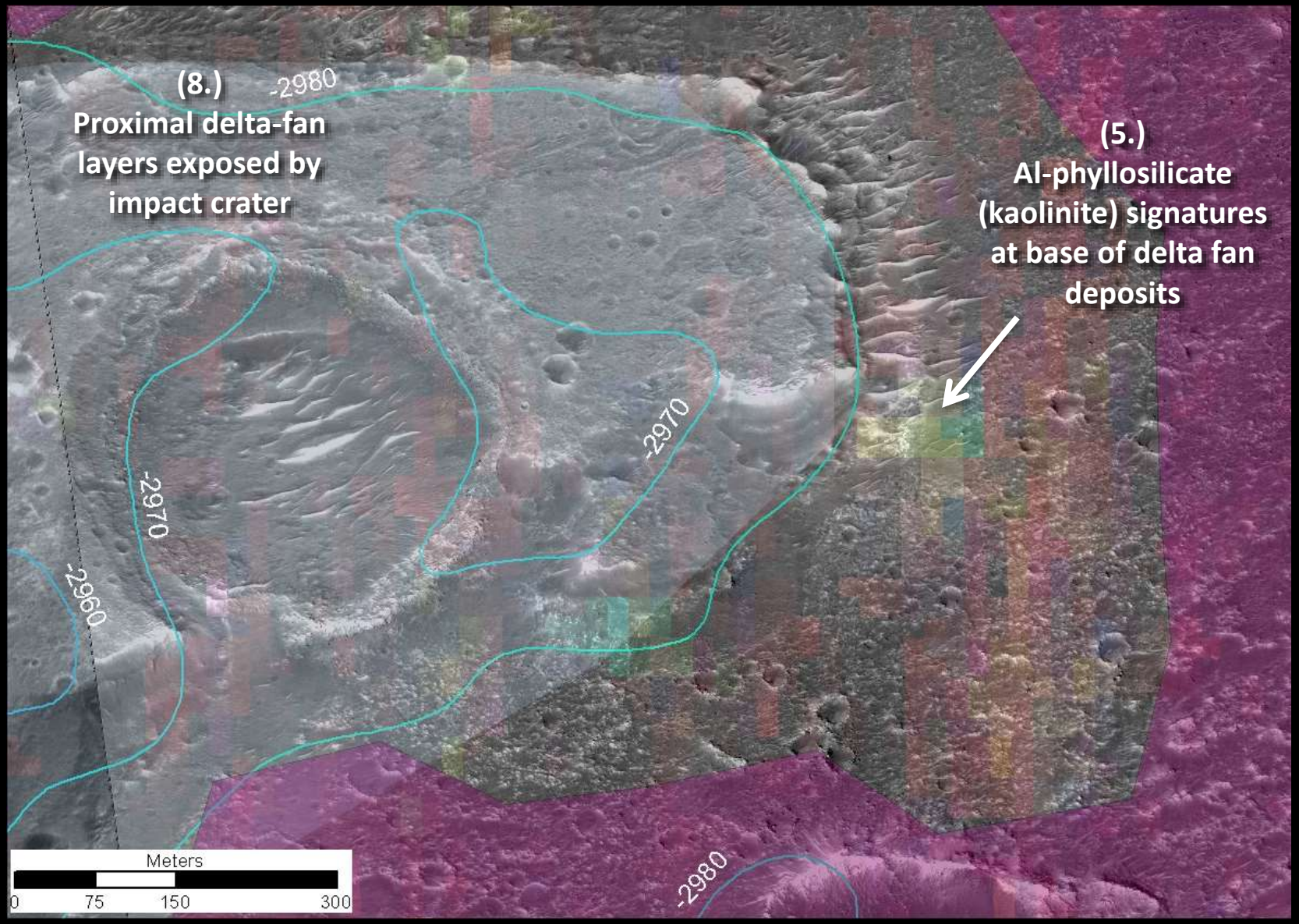
3. Delta-fan in paleo-basin as main target

10s of meters thick, stratigraphy exposed



3. Delta-fan in paleo-basin as main target

10s of meters thick, stratigraphy exposed



3. Delta-fan in paleo-basin as main target

Age from crater counts: > 3 Ga

Undergoing erosion

(figure removed)

4. Fe/Mg-phyllosilicates (Fe^{2+}) in noachian basement.

Prob. late Noachian alteration; typical « Phyllosian » clays

Basement unit

Delta-fan deposit

Basement unit

(figure removed)

Mawrth-Vallis-like stratigraphy outcrops

4. Fe/Mg-phyllosilicates (Fe^{2+}) in Noachian basement.

Alteration of Noachian units spans 100s of km

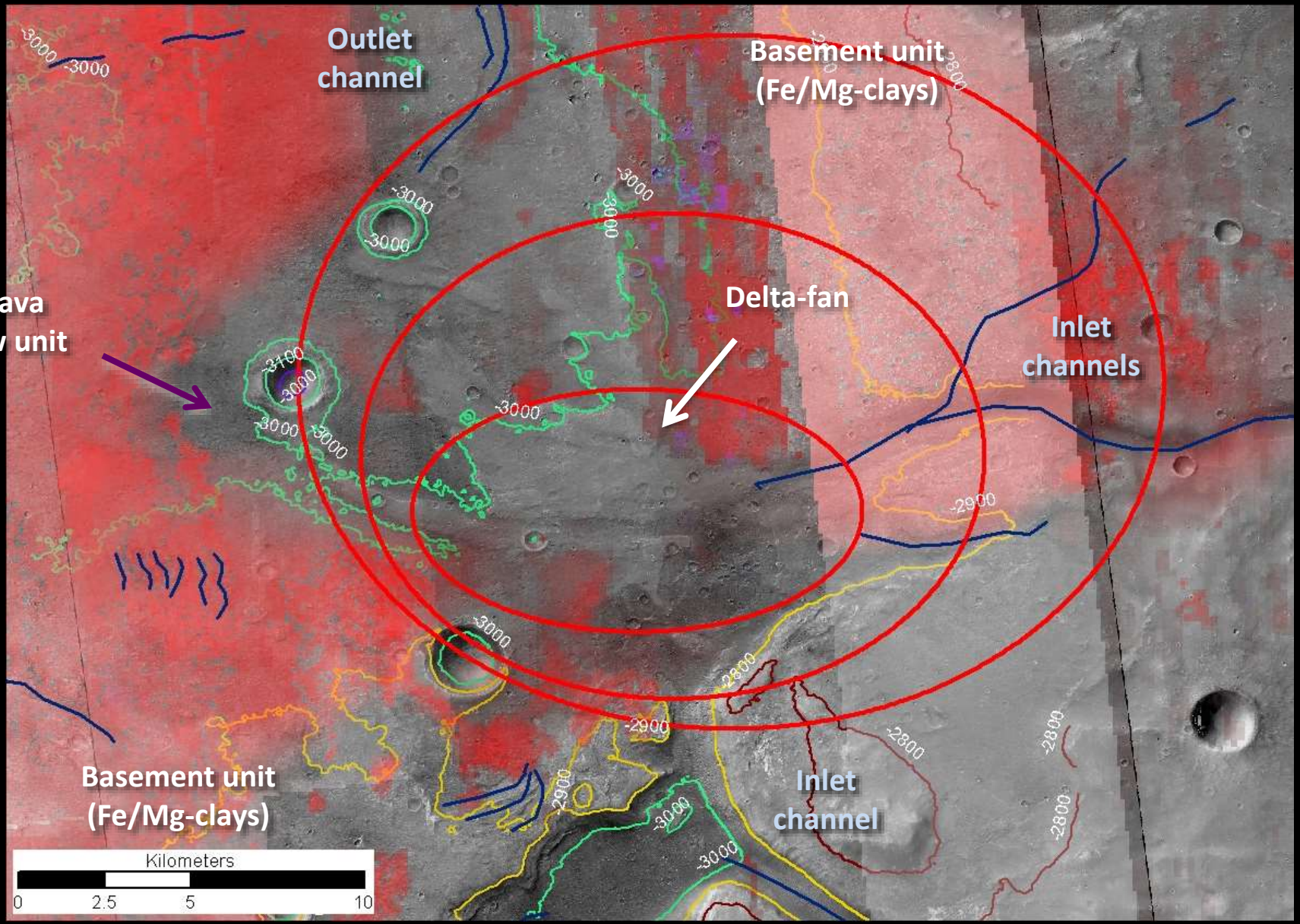
OMEGA & CRISM MSP :

2.3 microns band, **Fe/Mg-Phyllosilicates**

(figure removed)

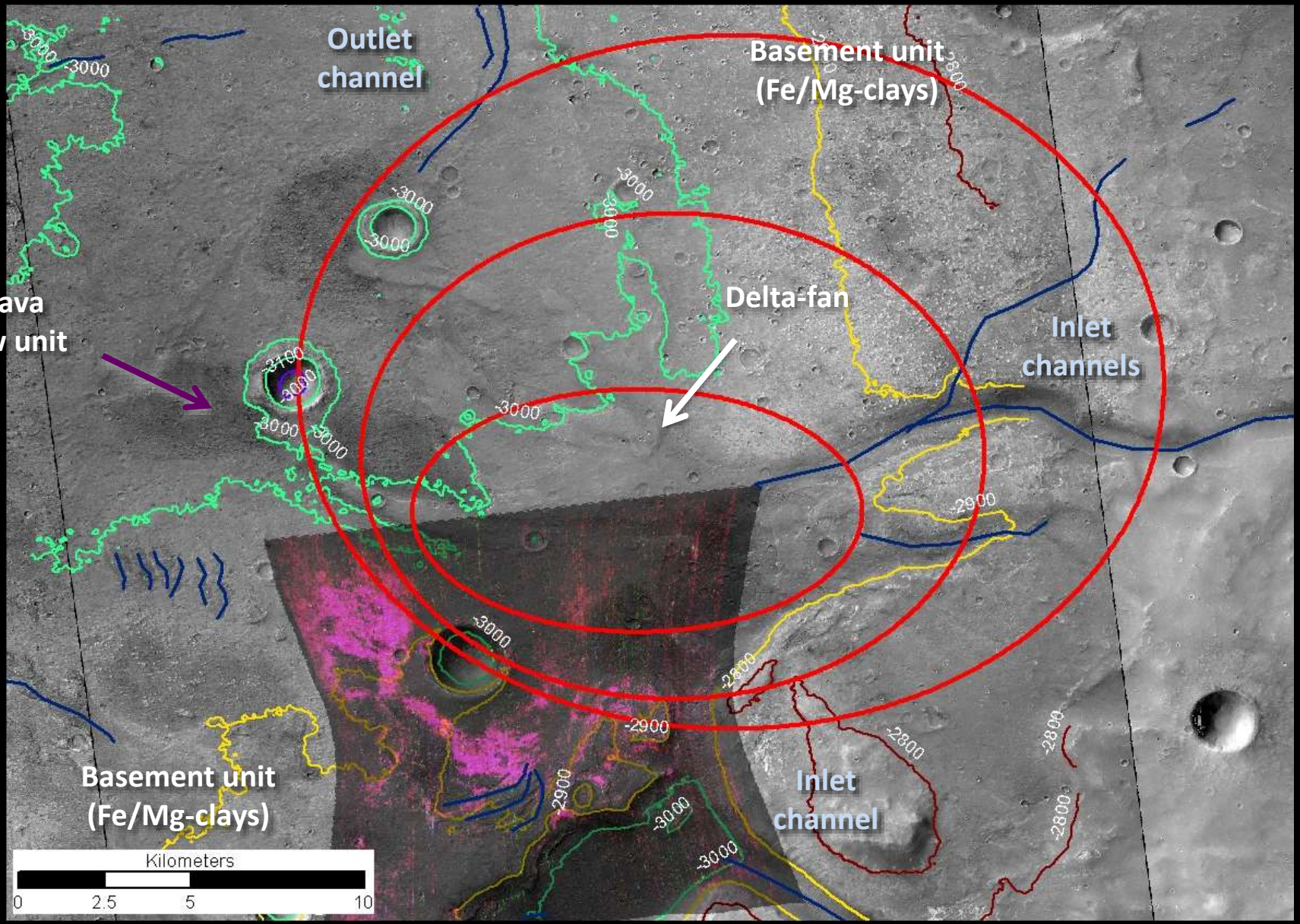
4. Fe/Mg-phyllosilicates (Fe^{2+}) in Noachian basement.

Around delta-fan



4./5. Fe/Mg-phyllosilicates and other alteration minerals

Only one (!) targeted CRISM observation, on edge of ellipse



4./5. Hydrated minerals in ellipse: Fe/Mg-phyllos, hydrated silica, kaolinite

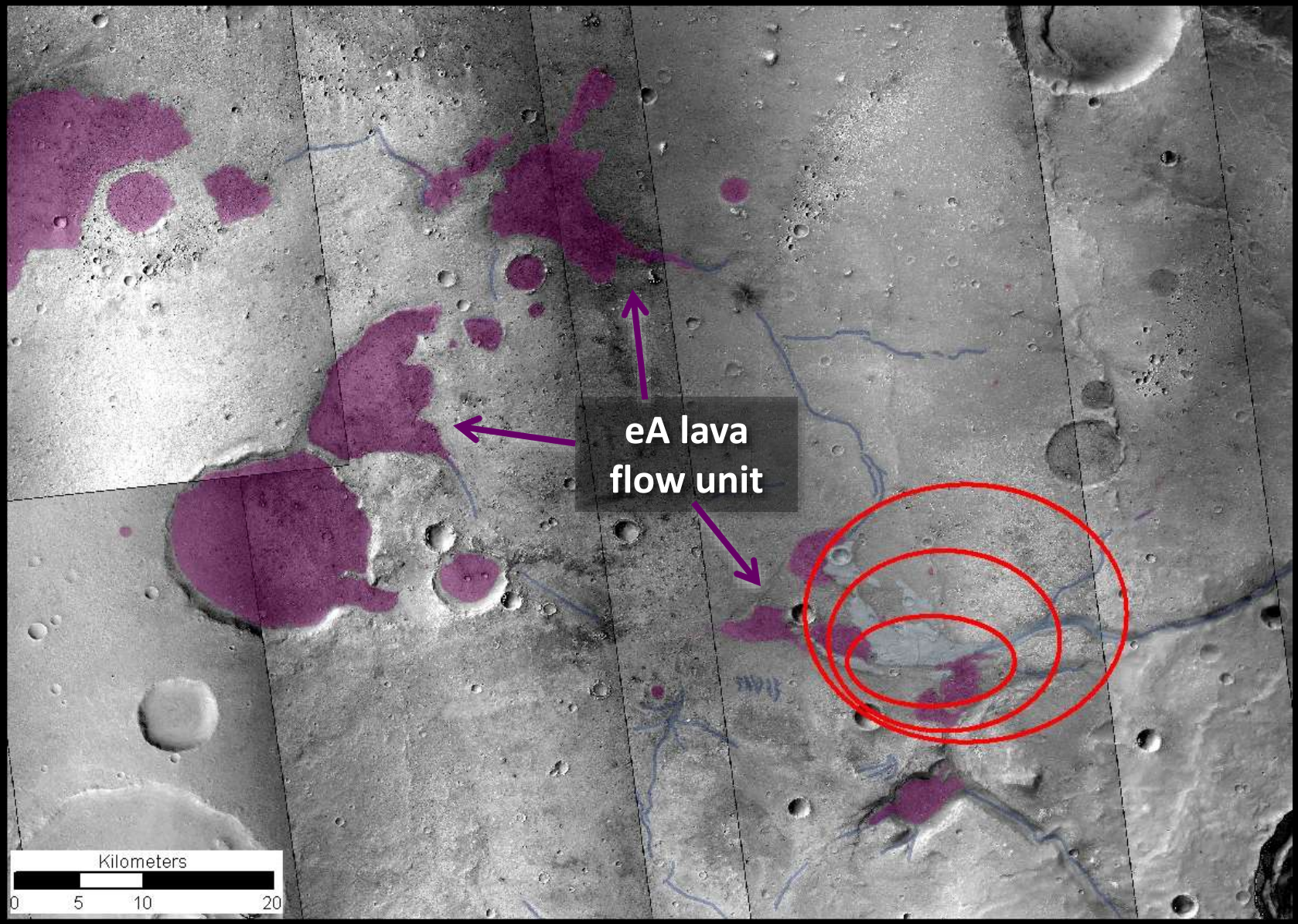
4./5. Hydrated minerals in ellipse: Fe/Mg-phyllos, hydrated silica, kaolinite

Possible **carbonates (Fe/Mg)** in deposits overlying (or part of) the Fe/Mg-phyllosilicate bearing basement

(figure removed)

6. Early Amazonian lava flow unit:

dated igneous unit, stratigraphically on top, in continuing erosion



6. Early Amazonian lava flow unit:

dated igneous unit, stratigraphically on top, in continuing erosion

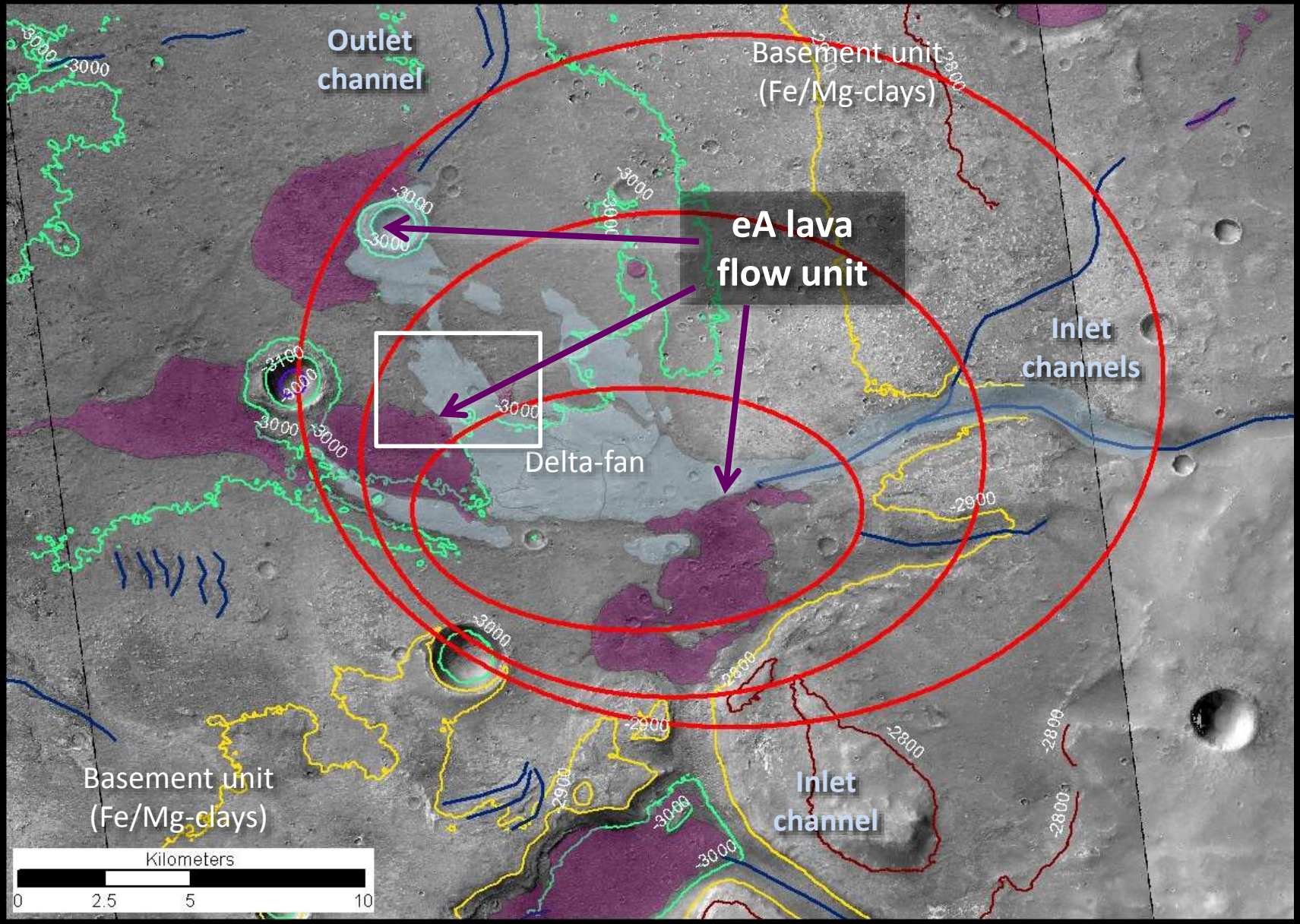
Crater counts on area preserved from erosion (within a depression):
model age of **~2.6 Ga**

→ sample from this unit would allow calibration of model ages

(figure removed)

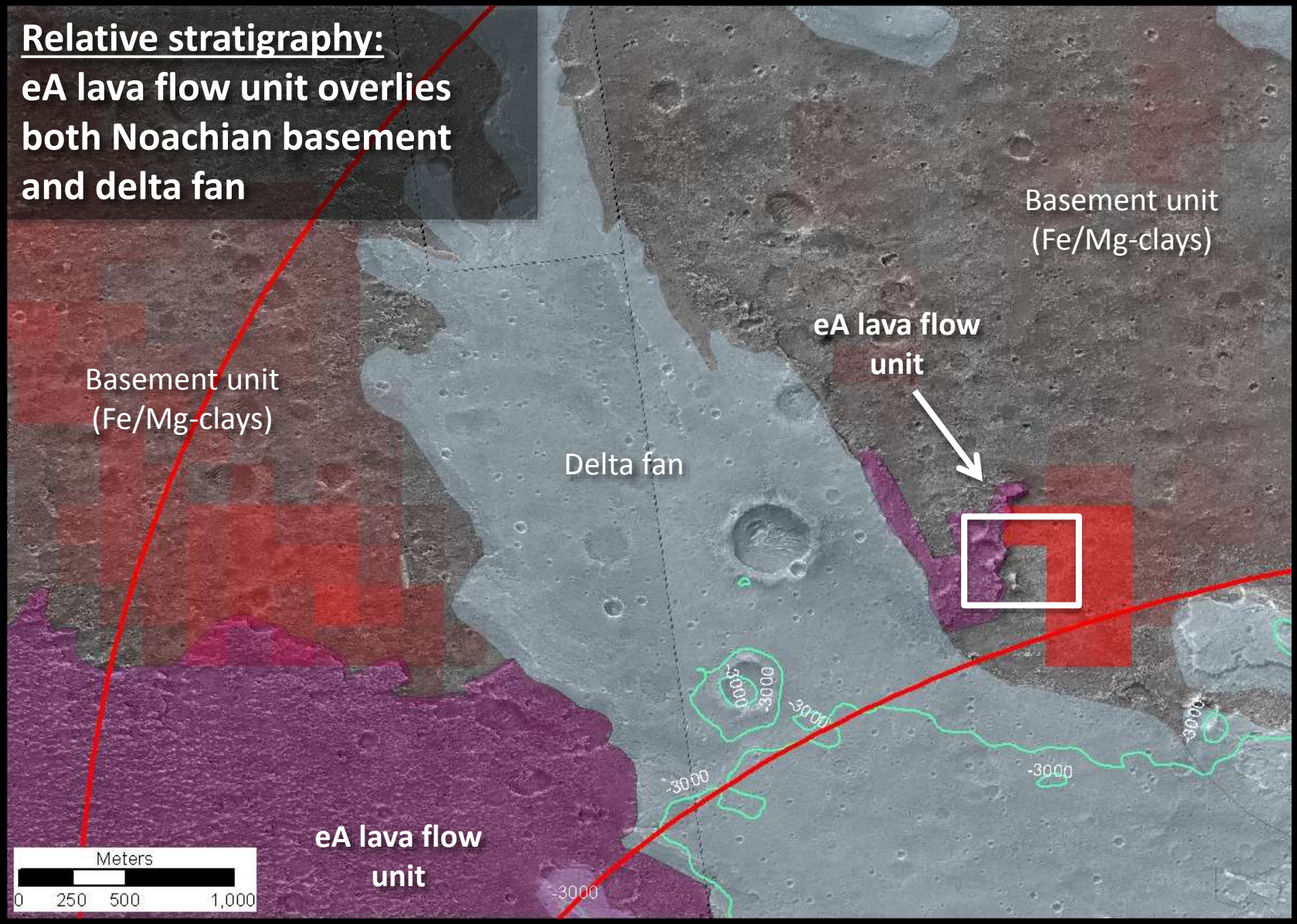
6. Early Amazonian lava flow unit:

dated igneous unit, stratigraphically on top, in continuing erosion



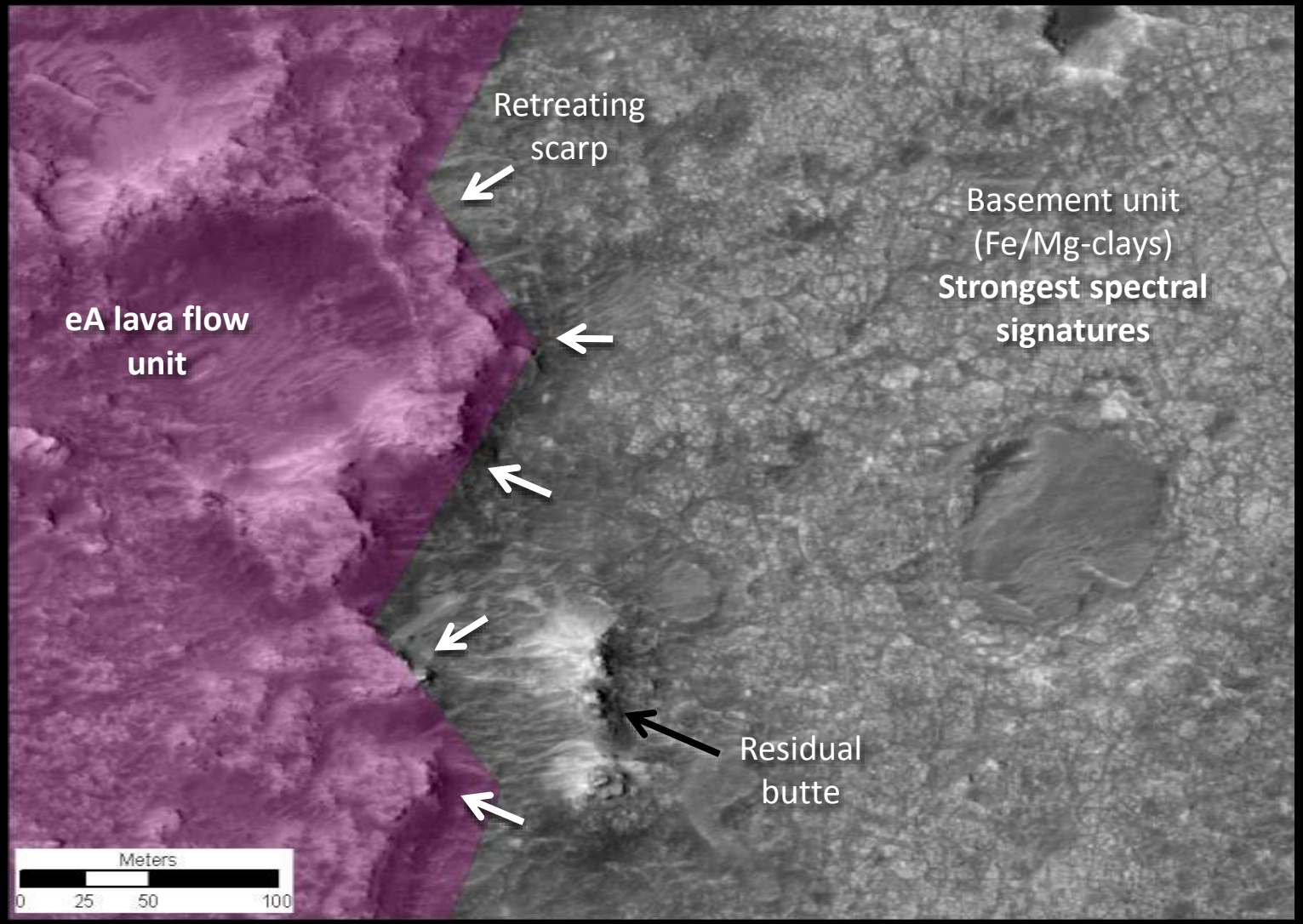
6. Early Amazonian lava flow unit:

dated igneous unit, stratigraphically on top, in continuing erosion



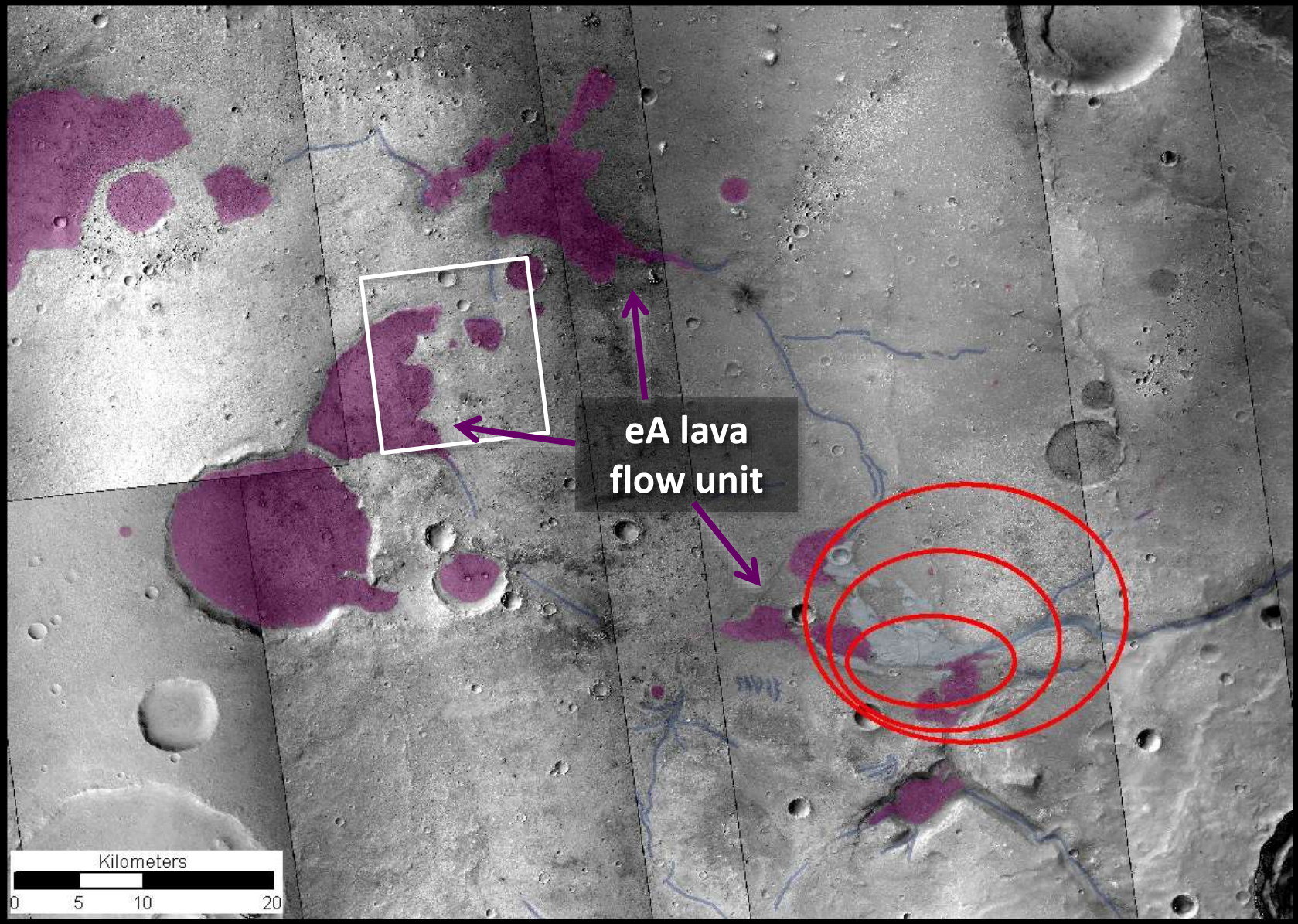
7. Early Amazonian lava flow unit:

dated igneous unit, stratigraphically on top, in continuing erosion



7. Early Amazonian lava flow unit:

dated igneous unit, stratigraphically on top, in continuing erosion



7. Early Amazonian lava flow unit:

dated igneous unit, stratigraphically on top, in continuing erosion

(figure removed)

Summary: Oxia Planum History

(figure removed)

Oxia Planum Highlights

1. **Noachian** basement (4 Ga), layered (sedimentary or igneous) and altered
2. **Fluvial** valleys and channels on Noachian basement
3. **Delta-fan** likely lN/eH (3.8-3.6 Ga), synchronous with fluvial features
4. **Fe/Mg-phyllosilicates** (ferrous iron: Fe2+) in late noachian unit.
5. Other alteration minerals include **Al-phyllosilicates** in delta-fan, **hydrated silica** on edge of igneous unit, possible **carbonates** with Fe/Mg-clays.
6. **Early Amazonian lava flow unit** (~ 2.6 Ga): igneous unit with crater count and precise age.
7. **Continuing erosion** during Amazonian: **renewing of surface outcrops** and **renewing of potential biosignatures**.
8. Impact craters forming natural cross-sections, also secondaries from large nearby craters.

Oxia Planum ‘rubric’

Landing Site Factor	Mars 2020 Mission and Decadal Priority Science Factors																				
	Environmental Setting for Biosignature Preservation and Taphonomy of Organics								Type 1A & 1B Samples: Aqueous Geochemical Environments indicated by Mineral Assemblages								Type 2 Samples: Igneous		Context: Martian History Sampled, Timing Constraints				
	Deltaic or Lacustrine (perennial)	Lacustrine (evaporitic)	Hydrothermal (<100°C) surface	Hydrothermal (<100°C) subsurface	Pedogenic	Fluvial/Alluvial	No diagenetic overprinting	Recent exposure	Crustal phyllosilicates	Sedimentary clays	Al clays in stratigraphy	Carbonate units	Chloride sediments	Sulfate sediments	Acid sulfate units	Silica deposits	Ferric Ox./Ferrous clays	Igneous unit (e.g., lava flow, pyroclastic, intrusive)	2nd Igneous unit	Pre- or Early-Noachian Megabreccia	Oldest stratigraphic constraint	Youngest stratigraphic constraint	Stratigrapy of units well-defined	Dateable surface, volcanic (unmodified crater SFD)
Oxia Planum	●		?		~	●	?	●		●	~	~				●	●	●	~		mN	eA	●	●